

What is claimed is:

5 1. A shutdown method for a pressurized water reactor (PWR) following interruption of power operation, the PWR having a reactor coolant system (RCS) including a reactor pressure vessel (RPV) containing fuel assemblies, comprising the steps of:

cooling reactor coolant containing dissolved hydrogen in the RCS;

adding boron to the reactor coolant in the RCS;

10 adding a decontamination reagent into the boron-containing reactor coolant, the decontamination reagent including a reducing agent to reduce iron and nickel in the RCS and a chelant to complex the iron and nickel;

15 circulating the reactor coolant containing the decontamination reagent through the RCS, including through the RPV containing the fuel assemblies, to dissolve and complex the iron and nickel;

removing complexed iron and nickel from the reactor coolant;

after adding at least a portion of the decontamination reagent, degassing the RCS to remove hydrogen gas and then adding an oxidant to oxidize the residual dissolved hydrogen and decontamination reagent in the reactor coolant; and

20 reducing the gamma emitting activity of the reactor coolant.

25 2. The method of Claim 1 wherein the step of adding a decontamination reagent comprises: adding the decontamination reagent to the reactor coolant when the temperature of the reactor coolant in the RCS is between 180°F and 240°F.

3. The method of Claim 2, wherein the step of adding decontamination reagent comprises: adding the decontamination reagent the reactor coolant when the temperature of the reactor coolant in the RCS is between 240°F and 200°F.

30 4. The method of Claim 1 wherein the step of adding a decontamination reagent comprises: adding EDTA to reduce the iron and an organic acid to complex the iron.

5. The method of Claim 1 wherein the step of adding a decontamination reagent comprises: adding an aqueous vanadous picolinate solution.

5 6. The method of Claim 1 wherein the step of removing complexed iron comprises: removing complexed nickel along with the complexed iron.

7. The method of Claim 1 wherein the cooling water contains lithium and the step of removing complexed iron comprises: removing the lithium along with the complexed iron.
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8. The method of Claim 1 wherein the step of adding an oxidant comprises: adding hydrogen peroxide.

15 9. The method of Claim 1 wherein the step of reducing the gamma emitting activity comprises: reducing the activity to 0.05 microCuries/cc or less.

10. The method of Claim 1, wherein the PWR has a residual heat removal system (RHRS) connected with the RCS, including the additional step of: removing dissolved oxygen from reactor coolant in the RHRS before the step of introducing a decontamination reagent.
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11. The method of Claim 1, including the additional step of: adding zinc to the reactor coolant after interrupting the power operation and before restarting the PWR.
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12. The method of Claim 11, wherein the step of adding zinc comprises: adding zinc to the reactor coolant while adding the decontamination reagent to the reactor coolant.
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13. The method of Claim 12, wherein the step of adding zinc comprises: adding zinc to the reactor coolant while adding the oxidant to the reactor coolant.